7. WATER AND SEDIMENT QUALITY

This section presents a summary of the available water and sediment quality data for the project area. This summary also identifies additional data needs and potential impacts from inflows that are to be considered in the development and evaluation of restoration alternatives for Ballona Wetlands. A literature review was conducted and existing data obtained and summarized. This section does not summarize all the existing data, but focuses on the more recent and comprehensive data sets in order to develop a baseline condition for alternative evaluation.

7.1 BASELINE WATER QUALITY OF BALLONA CREEK

7.1.1 Water Chemistry

The most comprehensive and recent data set of water quality in Ballona Creek is collected by the Los Angeles Department of Public Works (LADPW) as part of the Core Monitoring Program required under the municipal separate storm sewer systems (MS4s) National Pollutant Discharge Elimination System (NPDES) permit. The Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities within the Los Angeles County Flood Control District (collectively referred to as Permittees) are covered under this municipal NPDES permit for discharge of urban runoff to waters of the United States. The Core Monitoring Program includes wet and dry weather sampling and analysis of water samples within Ballona Creek watershed, upstream of the wetland and above the tidally-influenced sections of the creek. This monitoring program includes bioassessment surveys within the creek channel and shoreline sampling and analysis for bacteriological indicators along the Santa Monica Bay shoreline. The results of this monitoring are presented in the LADPW Integrated Receiving Water Impact Report (Weston, 2005). The following discussion summarizes the findings of this report.

Water quality monitoring has been conducted during the past 10 years at the Ballona Creek mass emission site (S01) as shown on Figure 7-1. Water quality monitoring has also been conducted at six Tributary Monitoring Stations that were established in 2004-2005. The locations of these monitoring points are shown on Figure 7-1. Table 7-1 presents the annual mean concentration for constituents measured at the Ballona Creek mass emission site from 1994 to 2005 for both wet and dry weather sampling events. The monitoring program has identified several constituents of concern (COCs) that persistently exceed the water quality objectives (WQOs). The lowest WQOs used to compare with the average concentrations are shown on Table 7-1 and are based on freshwater criteria. The criteria used for metals is based on the California Toxics Rule (CTR) Criterion Continuous Concentrations (CCC) adjusted for hardness as described in the CTR using the average hardness for the year reported.

Table 7-1. Annual Mean Concentration for Constituents Measured at the Ballona Creek Mass Emission Site, 1994 to 2005

Constituent	Units	Lowest WQO[1]	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	Frequency Ratio	Mean Exceedance Ratio[2]
General															
Alkalinity	mg/l				27.0	68.6	69.0	66.7	68.1	60.9	189.2	166.6	114.7	0.0	
Bicarbonate	mg/l				27.0	68.6	69.0	80.1	82.9	74.3			166.3	0.0	
BOD	mg/l				29.4	19.7	45.9	12.9	9.4	19.2	10.7	16.7	21.3	0.0	
Calcium	mg/l				10.3	30.6	31.5	26.0	27.1	25.3			43.1	0.0	
Carbonate	mg/l								1.0	1.0			1.0	0.0	
Chloride	mg/l	500			5.9	29.1	24.2	27.9	25.1	22.8	73.7	75.1	40.9	0.0	0.1
COD	mg/l				118.2	103.2	63.7	41.6	53.1	148.1	64.7	43.3	55.5	0.0	
Cyanide	mg/l	0.004							0.01	0.01	0.01	0.01	0.01	1.0	1.7
Dissolved Oxygen	mg/l	<5									8.6	9.9	10.3	0.0	0.5
Fluoride	mg/l	1.6				0.1	0.2	0.2	0.2	0.2	0.4	0.3	0.3	0.0	0.2
Hardness	mg/l				34.0	124.4	117.8	97.2	126.1	108.2	276.2	273.0	171.4	0.0	
Magnesium	mg/l				2.0	11.7	9.5	7.9	11.8	11.8			15.5	0.0	
MBAS	mg/l						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	
Oil and Grease	mg/l		2.2	3.0	2.5		7.1	3.5	4.0	5.7	3.8	2.5	2.1	0.0	
pH		6.5/8.5			7.1	7.1	7.4	7.2	7.3	7.2	8.2	7.6	7.0	0.0	
Potassium	mg/l				1.8	3.5	3.5	3.4	3.8	4.5			4.7	0.0	
Sodium	mg/l				5.4	19.3	22.9	20.7	24.5	25.2			34.1	0.0	
Specific Conductance	umhos/cm				113.3	357.0	346.2	342.4	322.0	306.5	786.0	798.6	468.2	0.0	
Sulfate	mg/l	500			8.8	53.4	42.8	38.8	41.2	40.5	106.2	124.1	62.6	0.0	0.1
Total Dissolved Solids	mg/l	2000			69.5	221.6	217.8	206.5	194.5	206.3	511.0	503.2	282.8	0.0	0.1
Total Organic Carbon	mg/l				5.1	8.7	11.8	9.2	9.5	14.6	7.3	6.5	10.7	0.0	
Total Phenols	mg/l								0.1	0.1	0.1	0.1	2.5	0.0	
Total Suspended Solids	mg/l				108.5	264.8	200.7	170.2	164.9	291.7	199.0	63.6	385.4	0.0	
TPH	Mg/l			2.57	2.99	2.69		2.73	2.34	3.19	2.35	1.70	0.37	0.0	
Turbidity	ntu	225			30.0	81.3	91.0	65.7	47.0	62.5	17.9	15.6	23.3	0.0	0.2
Volatile Suspended Solids	mg/l				42.0	76.0	61.5	48.3	46.6	82.8	14.2	26.8	98.8	0.0	
Nutrients															
Ammonia	mg/l				0.23	0.76	0.45	0.63	0.56	0.45			0.84	0.0	
Dissolved Phosphorus	mg/l				0.17	0.31	0.24	0.27	0.20	0.32	0.20	0.19	0.26	0.0	
Kjeldahl-N	mg/l				1.67	2.38	4.48	2.82	2.20	3.94	3.16	1.16	3.84	0.0	
NH3-N	mg/l				0.18	0.63	0.37	0.52	0.47	0.37	0.54	0.26	0.70	0.0	
Nitrate	mg/l				2.14	4.04	3.64	5.23	3.04	2.18	3.66	4.28	1.80	0.0	
Nitrate-N	mg/l	10			0.48	0.91	0.82	1.28	0.70	0.49	0.83	1.01	0.50	0.0	0.1
Nitrite-N	mg/l	1			0.06	0.10	0.18	0.14	0.21	0.16	1.01	0.42	0.24	0.1	0.3
Total Phosphorus	mg/l				0.42	0.34	0.35	0.36	0.24	56.00	0.31	0.21	0.43	0.0	
Indicator Bacteria															
Fecal Coliform	mpn/100ml	400	209,500	3,301,667	73,000	3,103,333	65,293	137,556	2,538,375	277,625	88,753	62,320	20,325	1.0	2245
Enterococcus	mpn/100ml	104	355,283	1,203,333			196,667	168,911	615,000	276,000	118,670	74,216	115,125	1.0	3337
Fecal Streptococcus	mpn/100ml		401,667	1,853,333	291,667	430,000	266,693	348,222	1,000,000	431,000	128,670	108,416	152,625	0.0	
Total Coliform	mpn/100ml	10,000	528,333	4,633,333	2,891,667	3,486,667	441,539	378,889	3,506,375	482,000	187,503	166,220	143,100	1.0	153
Metals															
Dissolved Aluminum	ug/l					1284.3	77.2	119.2	71.2	50.0	50.0	50.0	50.0	0.0	

Table 7-1. Annual Mean Concentration for Constituents Measured at the Ballona Creek Mass Emission Site, 1994 to 2005

Constituent	Units	Lowest WQO[1]	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	Frequency Ratio	Mean Exceedance Ratio[2]
Dissolved Antimony	ug/l								2.5	1.8	1.3	1.6	1.4	0.0	
Dissolved Arsenic	ug/l								2.5	2.0	2.2	2.4	1.8	0.0	
Dissolved Barium	ug/l				8.0	46.9	35.4	38.1	29.5	33.3			34.6	0.0	
Dissolved Berylium	ug/l								0.5	0.5	0.5	0.5	0.5	0.0	
Dissolved Boron	ug/l					164.0	194.3	132.8	133.1	125.6			297.6	0.0	
Dissolved Cadmium	ug/l	1-4.7							0.5	0.5	0.5	0.5	0.5	0.0	0.2
Dissolved Chromium	ug/l	27-150.3			2.8				3.0	1.6	2.7	2.8	2.0	0.0	0.0
Dissolved Chromium +6	ug/l								5.0	5.0	5.0	5.0	5.0	0.0	
Dissolved Copper	ug/l	3.6-21.3			2.3	30.4	9.3	8.8	6.9	9.9	7.1	9.8	7.4	0.3	0.9
Dissolved Iron	ug/l				117.5	1679.9	103.1	246.7	129.0	210.7	113.3	76.0	95.2	0.0	
Dissolved Lead	ug/l	0.8-7.5				19.4			2.5	1.7	2.1	2.2	2.0	0.2	1.4
Dissolved Manganese	ug/l					85.4			50.0	61.3			50.0	0.0	
Dissolved Mercury	ug/l								0.5	0.5	0.5	0.5	0.5	0.0	
Dissolved Nickel	ug/l	20.9-122.9			2.9	11.3			3.6	4.7	5.3	4.3	4.4	0.0	0.1
Dissolved Selenium	ug/l								2.5	2.5	3.3	3.4	2.5	0.0	
Dissolved Silver	ug/l								0.5	0.5	0.5	0.5	0.5	0.0	
Dissolved Thallium	ug/l								2.5	2.5	2.5	2.5	2.5	0.0	
Dissolved Zinc	ug/l	47-277.1			46.3	154.9	50.1		57.0	49.2	30.0	43.8	34.5	0.1	0.5
Total Aluminum	ug/l	1000				2320.0	446.1	341.3	400.8	76.0	73.7	128.0	2984.6	0.3	0.8
Total Antimony	ug/l	6							2.5	1.7	1.4	1.7	2.4	0.0	0.3
Total Arsenic	ug/l	32			1.4				2.5	1.5	2.3	2.5	2.8	0.0	0.1
Total Barium	ug/l				20.5	72.4	47.7	50.8	36.8	36.7			101.3	0.0	
Total Beryllium	ug/l	4							0.5	0.5	0.5	0.5	0.5	0.0	0.1
Total Boron	ug/l					236.6	245.3	176.1	157.0	168.2			781.4	0.0	
Total Cadmium	ug/l	1.1-5.5				0.8			0.5	0.5	0.5	0.5	0.9	0.0	0.2
Total Chromium	ug/l	50			5.8	6.4			3.0	2.4	7.0	5.5	8.0	0.0	0.1
Total Chromium +6	ug/l										5.0	5.0	5.0	0.0	
Total Copper	ug/l	3.7-22.2			12.0	39.3	18.3	16.1	14.8	20.0	12.2	16.4	49.5	0.8	2.0
Total Iron	ug/l				404.0	7564.6	597.2	832.5	797.0	370.0	238.0	188.0	4128.6	0.0	
Total Lead	ug/l	0.8-11.6			8.8	35.1	6.5	4.9	6.1	2.4	2.7	1.9	36.6	0.7	3.4
Total Manganese	ug/l					126.0			57.4	164.4			169.6	0.0	
Total Mercury	ug/l	0.16			19.9				0.5	0.5	0.5	0.5	0.5	1.0	23.3
Total Nickel	ug/l	20.9-123.2			4.0	6.9	6.8	5.7	4.4	5.5	11.2	5.4	10.6	0.0	0.1
Total Selenium	ug/l	60			2.6				2.5	2.5	3.3	3.6	2.5	0.0	0.1
Total Silver	ug/l	2.8							0.5	0.5	0.5	0.5	0.61	0.0	0.2
Total Thallium	ug/l	2							2.5	2.5	2.5	2.5	2.5	1.0	1.3
Total Zinc	ug/l	48-283			80.3	382.1	95.9	73.1	87.0	52.1	49.7	60.1	180.4	0.2	0.9
Pesticides															
Diazinon	ug/l	0.08					0.005		0.005	0.074	0.051	0.030	0.037	0.0	0.4
Prometryn	ug/l										1	1	2.59	0.0	

[1] WQO for metals are hardness dependent and were based on minimum hardness by year.

[2] Mean Exceedance Ratio calculated using annual mean concentrations reported up to four significant figures. Ratio shown may not exactly equal ratio of mean values shown in table due to rounding of presented means.

Blue = WQO Exceedances; Yellow = DL above WQO; Orange = Frequency ratio > 0.5, Mean exceedance > 1.0.

The COCs identified include cyanide, indicator bacteria (total coliform, fecal coliform and enterococcus) and metals (total copper and total and dissolved lead). None of the COCs had concentrations that were shown to have significantly increasing or decreasing trends. However, bicarbonate, potassium, and MBAS were shown to have significantly increasing concentrations, while the concentrations of total petroleum hydrocarbons significantly decreased during the same time period (1996-2004).

Table 7-2 summarizes the constituents of concern based on the mass emission data and compares them to pollutants on the 303(d) list for Ballona Creek. Constituents indicating increasing trends are also shown in Table 7-2. The first column of the table lists constituents of concern as determined from the integrated data set of annual mean values; the second column lists constituents that show an increasing trend even though concentrations may be below water quality objectives; and the third column is presented for comparison purposes and provides constituents that are 303(d) listed. The constituents listed as COCs that are consistent with the 303(d) listing include fecal and total coliform and dissolved lead. The magnitude of the exceedances of the WQOs for the COCs listed in Table 7-2 is graphically shown in Figure 7-2. Figure 7-2 shows that the greatest exceedances are observed for the bacteriological indicators and total lead and copper.

Table 7-2. COCs, Increasing Trends and Comparison to 303(d) List for Ballona Creek

Constituent	Constituents of Concern Based on Mass Emission Data Frequency/Magnitude	Constituents Indicating Increasing Trend	Constituents on the 303(d) List
Cyanide	X		
Enterococcus	X		
Fecal Coliform	X		X
Total Coliform	X		X
Total Copper	X		
Total Lead	X		
Total Selenium			X
Dissolved Copper			X
Dissolved Lead	X		X
Dissolved Zinc			X
MBAS		X	
Potassium		X	
Bicarbonate		X	

These results represent water quality conditions at the base of the watershed above the tidal prism. Based on these results, freshwater inputs from Ballona Creek would be expected to contain, on average, concentrations of bacteriological indicators and several total and dissolved metals (copper, lead, and zinc) that exceed the water quality objectives. Discussion of potential long-term impacts to wetland habitat that would receive these waters is presented later in this section.

In addition to wet and dry weather sampling at the mass emission site, LADPW has conducted tributary sampling in 2004-2005 at the locations shown on Figure 7-1 (sites identified as TS-07 to TS-12). The results of this sampling are presented on Figure 7-3 for each sampling event and whether the concentration detected in the stormwater samples exceeded the WQO. The results from the Ballona Creek mass emission site are also presented for comparison. Boxes that are colored under each sampling event indicate an exceedance of the WQOs at that designated tributary or mass emission sampling site for the constituent listed. The results in Figure 7-3 indicate that bacteriological indicators, total copper, and total lead exceeded WQOs at the mass emission site on nearly every monitoring date and those exceedances coincided at many, if not all tributaries. Total zinc and cyanide had exceedances at the mass emission site for two events with corresponding exceedances in many of the tributary stations. Other constituents had less of a connection between water quality exceedances at the mass emission site and exceedances at the tributary stations.

No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, Sepulveda Creek (TS08) and the further upstream tributaries (see Figure 7-1) appear to exhibit greater exceedances of the WQO for the selected metals. These results are consistent with the findings of the dry weather characterization study of Ballona Creek conducted by the Southern California Coastal Water Research Project. The results of this study also indicated that the distribution of higher metals and elevated bacteria concentrations for the dry weather flows was ‘bimodal’ (Southern California Coastal Water Research Project, 2004). The highest concentrations were detected between kilometers 3 and 6, immediately upstream of the tidal portion of Ballona Creek, and between kilometers 9 and 12, below the portion of the watershed where Ballona Creek daylights from an underground storm drain to an exposed channel.

Shoreline monitoring for bacteriological indicators was conducted between 2001 and 2004 along the Santa Monica Bay shoreline within the Ballona Creek watershed. The locations of the shoreline sampling points are shown on Figure 7-1. The results reported from the shoreline monitoring indicated exceedances of bacteria standards of at least one indicator bacteria at all stations during dry or wet weather in all three sampling seasons, with more exceedances occurring during wet weather. These exceedances correspond with the bacteria exceedances that occurred at the mass emission site and the tributary stations within the Ballona Creek watershed.

In addition to the results reported by LADPW for Ballona Creek, additional metals data are presented in the Total Maximum Daily Load (TMDL) report for metals in Ballona Creek (U.S. EPA, Region IX, 2004). Additional data was collected by the City of Los Angeles from April 2001 through May 2003 and by the Southern California Coastal Water Research Project (SCCWRP) in May, July, and September 2003.

The City sampled four locations along Ballona Creek during dry weather, at National Boulevard, Overland Avenue, Centinella Boulevard, and Pacific Avenue. The data from National Boulevard and Overland Avenue are representative of Ballona Creek and were compared to freshwater criteria based on CTR values. Data from Centinella Boulevard and Pacific Avenue are representative of the tidal sections of Ballona Creek and were compared to salt water criteria.

In Ballona Creek, between 44 and 48 samples were analyzed for cadmium, copper, lead, total selenium, silver, and zinc. The acute criteria were exceeded for copper four times, for silver one time, and for zinc two times. The chronic criteria were exceeded for copper and lead seven times and for zinc two times. The detection limits for lead and selenium were, in many cases, above the chronic criteria.

In the tidal section of Ballona Creek, 48 samples were analyzed for cadmium, copper, lead, silver, and zinc. Selenium was analyzed in 44 samples. The acute criteria were exceeded 10 times for copper and twice for zinc. The chronic criteria were also exceeded 10 times for copper and twice for zinc, as well as seven times for lead. Detection limits for copper were, in many cases, above both the acute and chronic criteria. The detection limits for lead were above the salt water chronic criterion as they were for freshwater criterion. The detection limit for silver was higher than the acute criterion.

SCCWRP sampled 12 sites within Ballona Creek and 35-40 storm drain discharges (depending on whether the drain was flowing during sampling events) during dry weather. Three of the Ballona Creek sites were representative of the tidal section, while the remaining nine were representative of Ballona Creek above the tidal limit. In the tidal section, copper exceeded both the acute and chronic criteria in five samples, while lead exceeded the chronic criterion five times. The reporting limits were higher than the chronic criteria for lead, copper, and selenium and higher then the acute criteria for copper and silver. In all, 27 samples were analyzed for cadmium, copper, lead, selenium, and zinc, and 18 for silver at the tidal sites.

Other water quality data include the results of the State's Surface Water Ambient Monitoring Program (SWAMP), which included sampling at four stations in Ballona Creek, conducted in 2003 (LARWCQB, 2003). The results reported for the metals analysis at the sampling stations at the confluence with Centinella Creek indicated generally lower concentrations than detected in the tributary sampling in Centinella Creek by LADPW as summarized above. Concentrations reported for total phosphorus, nitrate as N, and sulfate at the four sample locations (Centinella Creek, Sepulveda Channel, Sawtelle Creek and middle of Ballona Creek) were all below the WQO.

7.1.2 Bioassessment

Stream bioassessment monitoring in Ballona Creek was conducted in October 2003 and October 2004 to assess biological integrity and to detect biological trends and responses to pollution in receiving waters within the watershed. The location of the bioassessment monitoring site is shown in Figure 7-1. The Ballona Creek site was located in an urbanized portion of the watershed. The benthic macroinvertebrate community had CFG Southern California Index of Biotic Integrity scores of six and 10, and quality ratings of Very Poor for both years. As summarized above, total copper and total and dissolved lead consistently exceeded water quality objectives in the stormwater samples collected at the mass emission site and many of the tributary locations. High concentrations of heavy metals are known to negatively impact macroinvertebrate communities (e.g. Winner et al., 1980). Bacteria levels were consistently well above the WQO, and while bacteria alone likely did not directly impact the benthic community, high densities generally indicate other water quality issues such as elevated fine organic matter or nutrients that could degrade the system. Two pesticides were detected in stormwater samples, diazinon and prometryn, and these would likely have a deleterious effect on the macroinvertebrate community.

7.1.3 Water Column Toxicity

Water column toxicity monitoring has been conducted for wet weather stormwater samples collected at the mass emission site in Ballona Creek for two storm events in 2004. The results of the toxicity testing on this sample indicated that stormwater did not affect cladoceran survival or reproduction. However, the toxicity results also indicated that sea urchin reproduction was inhibited. Toxicity monitoring performed prior to the 2004-2005 season also determined that some stormwater samples collected from Ballona Creek inhibited sea urchin fertilization. The Study of the Impact of Storm Water Discharge on the Beneficial Uses of Santa Monica Bay found that sea urchin fertilization was significantly reduced by exposure to undiluted wet weather stormwater samples collected from Ballona Creek in 1995-1996, 1996-1997, and 1997-1998. Stormwater from the season’s first storm demonstrated the greatest toxicity response. Dry season samples from 2002-2003 and 2003-2004 did not indicate toxicity effects, but wet season stormwater samples significantly inhibited sea urchin fertilization. Toxicity Identification Evaluations (TIEs) determined the toxicity in 2002-2003 stormwater was due to particulate-bound toxicants, one or more non-polar organic compounds and cationic metals. In 2003-2004 the toxic pollutant in stormwater was believed to be a volatile compound.

7.2 BASELINE SEDIMENT QUALITY IN THE TIDAL SECTION OF BALLONA CREEK

Sediment quality data for the tidal section of Ballona Creek was collected during the 2003 Southern California Bight Regional Monitoring Program. The tidal section of Ballona Creek was monitored to estimate the extent and magnitude of ecological change in the Southern California Bight and to determine the mass balance of pollutants that currently reside within the area. Sediments from five stations within the tidal section of Ballona Creek were analyzed for chemistry, toxicity, and benthic macroinvertebrate diversity. The locations of these monitoring stations are shown in Figure 7-4. As shown on Figure 7-4, the locations are within Ballona Creek and adjacent to the project area. Although no sediment samples were collected within the existing tidal marsh, these samples provide an indication of potential long-term sediment quality of the marsh if the primary inputs are from Ballona Creek. Concentrations of constituents in the samples would, however, be expected to be greater in the tidal section of Ballona Creek compared to the tidal marsh in Area B due to greater overall loading from the watershed. Flow into the existing tidal marsh (Area B) is restricted by tide-gates, but not eliminated. Furthermore, waters from Ballona Creek that flow into Area B are from the tidally influenced portion of the creek where mixing of the freshwater creek flows with the salt water of Santa Monica Bay occurs.

The results from these sampling events are presented in Table 7-3. Data is also summarized from results reported in the TMDL for Toxic Pollutants in the tidal section of Ballona Creek from sampling and analysis conducted by the Contaminated Sediments Task Force (CRWQCB, 2005). In the CRWQCB study, sediment chemistry data from samples collected from Southern California estuaries were compared to the Effect Range-Low (ER-L) and Effect Range-Median (ER-M) values to evaluate the potential for sediment to cause adverse biological effects (Long et al., 1995). The guidelines were intended to provide informal (non-regulatory) effects-based benchmarks of sediment chemistry data (Long et al., 1998). In addition, for each tidal ER-M, values were used to calculate a mean ER-M quotient (ERM-Q). The concentration of each constituent was divided by its ER-M to produce a quotient, or proportion of the ER-M equivalent to the magnitude by which the ER-M value is exceeded or not exceeded. The mean ERM-Q for each estuary was then calculated by summing the ERM-Qs for each constituent and then dividing by the total number of ERM-Qs assessed. ERM-Qs were not calculated for constituents below the detection limit and thus were not used in the generation of the mean ERM-Q. The mean ERM-Q thus represents an assessment for each estuary of the cumulative sediment chemistry relative to the threshold values. In this way, the cumulative risks of effect to the benthic community can provide a mechanism to compare estuaries. This method has been used and evaluated by several researchers (Hyland et al., 1999; Carr et al., 1996; Chapman, 1996; and Long et al., 1995) throughout the country.

The aggregate approach using an ERM-Q is a more reliable predictor of potential toxicity but should not be used to infer causality of specific contaminants. ER-L and ER-M values were originally derived to be broadly applicable and they cannot account for site-specific features that may affect their applicability on a more local or regional level. Local differences in geomorphology can result in chemicals being more or less available and therefore more or less toxic than an ER-L or ER-M value might indicate. Additionally, some regions of the country are naturally enriched in certain metals and local organisms have become adapted.

Table 7-3. Analytical Results for Constituents Analyzed in the Tidal Section of Ballona Creek

Constituent	Units	ER-L*	ER-M*	Station ID				
				4053	4213	5735	5767	5787
Toxicity								
Mean *Eohaustorius* Survival	%			<u>**0**</u>	59	<u>**27**</u>	<u>**19**</u>	90
Infauna Community Indices								
Number of species	#/0.1 m^2			37	12	45	53	85
Total abundance	#/0.1 m^2			16,836	5767	1628	1800	3809
Shannon-Wiener diversity				1.31	1.09	2.57	2.52	2.23
Evenness				0.36	0.44	0.67	0.63	0.50
Dominance				2	2	6	5	4
Sediment Size and TOC								
Gravel	%			55.00	55.70	0.21	0.29	0.68
Sand	%			35.62	42.34	48.53	57.80	79.65
Silt	%			8.62	1.80	48.76	39.84	18.97
Clay	%			0.84	0.16	2.50	2.07	0.70
Median size	microns			2222.89	2187.01	58.30	125.47	710.87
Mean size	microns			1759.90	2093.95	115.75	133.83	221.73
TOC	%			4.946	0.497	0.669	1.196	0.352
Metals	mg/kg							
Arsenic	mg/kg	8.2	70	4.01	2.37	3.54	7.52	2.97
Cadmium	mg/kg	1.2	9.6	0.84	0.13	0.83	0.96	0.31
Chromium	mg/kg	81	370	21.9	19.5	21.1	19.3	10.6
Copper	mg/kg	34	270	**36.4**	11.5	32.9	33.4	10.6
Lead	mg/kg	46.7	220	41.0	12.7	**111.0**	**59.3**	35.5
Mercury	mg/kg	0.15	0.71	0.11	0.03	0.05	0.08	0.03
Nickel	mg/kg	20.9	51.6	13.1	9.7	13.3	12.5	7.6
Silver	mg/kg	1	3.7	0.86	0.44	0.66	0.87	0.36
Zinc	mg/kg	150	410	**202.0**	73.5	**186.0**	**165.0**	107.0
Pesticides								
Total detectable DDT	µg/kg	1.58	46.l	**17.3**	1.4	**5.4**	**9.7**	0.0
Total detectable chlordane	µg/kg	0.6	6	<u>**21.6**</u>	1.3	0	0	0
PAHs								
Total detectable PAHs	µg/kg	4022	44,800	1929	69	182	488	408
PCBs								
Total detectable PCBs	µg/kg	22.7	180	0.0	0.0	8.0	0.0	0.0
Mean ER-M quotient				**0.44**	0.08	**0.15**	**0.14**	0.07

* Effects Range-Low and Effects Range-Median (Long et al., 1995)
Chemistry results in **bold** = exceeds ER-L
Chemistry results in <u>**bold**</u> = exceeds ER-M
Toxicity in **bold** = identified as moderately toxic (Bight 03 draft report, SCCWRP, 2004)
Toxicity in <u>**bold**</u> = identified as highly toxic (Bight 03 draft report, SCCWRP, 2004)
Mean ERM-Q in **bold** = above 0.10 threshold (Long et al., 1998)
NR = not reported
J = Estimated value above MDL and below RL

7.2.1 Sediment Chemistry

Sediments were analyzed for four groups of constituents: metals, pesticides, PAHs and PCBs (CRWQCB, 2005). Three metals, including copper, lead, and zinc, exceeded the ER-L at some of the stations within the tidal section of Ballona Creek. Copper exceeded the ER-L at one station, 4053, with a value of 36.4 mg/kg. Lead exceeded the ER-L at two stations, 5735 and 5767, with values of 111 and 59.3 mg/kg, respectively. Zinc exceeded the ER-L at three of the five stations with values ranging from 165 to 202 mg/kg. There were detections of all other metals at all stations; however, concentrations were below the ER-L and ER-M values.

The only pesticides with concentrations above ER-L and ER-M values were total detectable DDT and total detectable chlordane. Total detectable DDT exceeded the ER-L at three stations, with values ranging from 5.4 to 17.3 µg/kg. Total detectable DDT was below the ER-L value at station 4213 and was not detected at station 5787. Total detectable chlordane exceeded the ER-L at one station, 4213, with a value of 1.3 µg/kg and exceeded the ER-M at station 4053 with a value of 21.6 µg/kg. Total detectable chlordane was not detected at the other three stations.

Total detectable PAHs were below the ER-L values at all five stations monitored in the tidal section of Ballona Creek. Total detectable PCBs were only detected at station 5735 but were below the ER-L.

ERM-Q values were above the threshold of 0.10 at three out of the five stations monitored in the tidal section of Ballona Creek. Stations 4053, 5735 and 5767 had mean ERM-Q values above the 0.10 threshold, with values of 0.44, 0.15 and 0.14, respectively. The other two stations had mean ERM-Q values below 0.10, with values of 0.07 and 0.08.

Three of the stations displayed similar patterns of exceedances in the tidal section of Ballona Creek. Stations 4053, 5735, and 5767, the stations in the middle of the tidal section, had the most number of exceedances and all had mean ERM-Q values above the 0.10 threshold. The sediments at these stations were also identified as highly toxic to the test organisms (see below). The station located at the downstream end of the tidal section, 5787, did not have any exceedances, and had the lowest ERM-Q value and the highest percent survival rate of *Eohaustorius estuarius.*

In addition to the sediment quality data for the tidal section of Ballona Creek provided during the 2003 Bight program, additional metals data is presented in the draft Total Maximum Daily Load report for Toxic Pollutants in Ballona Creek (CRWQCB and U.S. EPA, Region IX, 2005). The TMDL report reviewed data compiled through the Contaminated Sediments Task Force (CSTF) in order to assess impacts to sediments.

The CSTF data was compared to ER-L and ER-M values for metals, pesticides, PCBs, and PAHs. More constituents were found to exceed ER-Ls and ER-Ms in the CSTF data then were found during Bight 2003 sampling, and previous exceedances were generally larger in magnitude.

Copper, lead, and zinc were found to be in exceedance in both 2003 and in the CSTF data. In addition to these three metals, cadmium and silver were also found to exceed ER-Ls in CSTF data. While no metals were found to exceed ER-Ms in 2003, both lead and zinc exceeded this upper limit in the earlier CSTF data.

DDTs and chlordane were both found to frequently exceed ER-Ms in the CSTF data, while chlordane exceeded this level only once in 2003 and DDT not at all. In comparison, chlordane was found to exceed the ER-M in 20 out of 20 samples compiled by the CSTF. Both DDTs and chlordane exceeded ER-Ls in 100% of CSTF sample data. CSTF data also included dieldrin results, which exceeded ER-Ls in 100% of the sample data.

PCBs exceeded the ER-L in 20 samples and exceeded the ER-M in 10 samples, both out of 28 total samples in the CSTF database. Only one sample analyzed in 2003 detected PCBs, and that value was below the ER-L.

PAHs were detected in eight out of eight samples in the CSTF database, with one sample exceeding the ER-L. Although PAHs were detected in all of the 2003 data, none exceeded limits.

7.2.2 Sediment Toxicity

The mean percent survival of the test organism, *E. estuarius,* exposed to Ballona Creek tidal sediments ranged from zero to 90%. Percent survival was the lowest at stations 4053, 5735, and 5767, with values of 0%, 27% and 19%, respectively. These values suggest that the sediments in these areas are toxic to the test organisms (Bight 2003 draft report, SCCWRP, 2004). The mean percent survival of *E. estuarius* at station 4213 was 59%, suggesting that the sediments in this area were moderately toxic to the test organisms. Station 5787 had a mean percent survival of 90%, which suggests that the sediments in this area were not toxic.

7.2.3 Benthic Community Structure

Total abundance ranged from 1,628 organisms/0.1m^2 at station 5735 to 16,836 organisms/0.1m^2 at station 4053. The total number of species ranged from 12 at station 4213 to 85 organisms/0.1m^2 at station 5787. Species diversity was highest at station 5735 with a value of 2.57 and lowest at station 4213 with a value of 1.09. Evenness values ranged from 0.36 at station 4053 to 0.67 at station 5735. Dominance values ranged from two to six.

7.2.4 Sediment Particle Size

Sand, gravel, and silt were the dominant sediment constituents at the stations monitored in the tidal section of Ballona Creek. Sand dominated the sediment composition at two stations, 5767 and 5787, followed by silt. Gravel was the dominant sediment constituent at stations 4053 and 4213 followed by sand; silt was the dominant constituent at station 5735, followed by sand. Median particle size ranged from 58.3 to 2222.9 microns. TOC content ranged from 0.35 to 4.95%. Station 4053 had the largest median particle size and the highest TOC content.

7.3 WATER AND SEDIMENT QUALITY DATA FOR THE EXISTING TIDAL MARSH

Water quality data from within the existing tidal marsh in Area B is limited. The City of Los Angeles Department of Public Works, Bureau of Sanitation collects field measurements of general water quality parameters that include salinity, dissolved oxygen, temperature, pH, and turbidity. Loyola Marymount University (LMU) is also conducting water quality measurements in the tidal marsh for salinity and bacteria (J. Dorsey, LMU). These measurements provide for comparison of general water chemistry, but not on potential impacts from inflows from Ballona Creek or urban runoff. Evaluation of the accumulation and potential impacts of constituents identified as COCs in Ballona Creek freshwater samples above the tidal prism or in water and sediments within the tidal section of Ballona Creek cannot be performed with the currently limited data set.

The research of existing available data did not identify any analytical results from water or sediment sampling within the existing tidal marsh in Area B. No chemical analytical data was identified for sediment samples in Areas A and C. Although the existing tidal marsh areas have been subject to tidal flows from Ballona Creek, these inflows have been restricted. Furthermore, the tidal marsh is not subject to the total flows and loadings from the Ballona Creek watershed, but restricted input from the tidal section and stormwater from drainage areas surrounding the marsh. Available results from tidal samples indicate exceedances of salt water criteria for several metals, including copper and lead.

Although sediment quality results are available from the tidal section of Ballona Creek, a direct correlation to the current sediment characteristics in the existing tidal marsh cannot be made due to the significant difference in long-term loading history of these sediments. The sediments within the tidal section of Ballona Creek have been subject to the total flows and loadings from the Ballona Creek watershed, compared to restricted flows and subsequent loadings into the tidal marsh.

7.4 WATER AND SEDIMENT QUALITY OF THE FRESHWATER MARSH

In order to comply with a series of permits from various agencies, annual monitoring is conducted during the wet and dry seasons at various locations throughout the Freshwater Marsh. The following sections summarizes the results of this monitoring program as they are presented for the Freshwater Marsh in the Playa Wetland Annual Report of Monitoring, Operation, and Maintenance, Year 2 (Center for Natural Lands Management and Geosyntec Consultants, 2005). The monitoring program within the Freshwater Marsh includes the following analyses:

- Field Parameters (DO, turbidity, pH, temperature, conductivity)
- Wet Chemistry (nutrients, bacteria, metals, pesticides, organics, SSC, hardness, salinity)
- Toxicity (acute and chronic for water flea and minnow)
- Sediments (metals, pesticides, organics, nutrients)

7.4.1 Field Parameters

The ranges of field parameters in the Freshwater Marsh are generally similar to those that would be expected in a natural wetland system. A summary of this data is provided below:

- *Dissolved Oxygen*: Dissolved oxygen (DO) concentrations at the Freshwater Marsh inlets range from 3.9 mgl^{-1} to 13.1 mgl^{-1}, with an average of approximately 6.7 mgl^{-1}. Outlet DO concentrations range from 3.7 to 13.5 mgl^{-1}, with an average concentration of 8.3 mgl^{-1} during the summer months.
- *Temperature*: Water temperatures in the Freshwater Marsh range from approximately 55 degrees Fahrenheit during the winter to 72 degrees Fahrenheit during the summer months.
- *Conductivity*: Specific conductance at the Freshwater Marsh showed a high degree of variability, with values ranging from 330 to 2,120 umhos/cm at the inlets and 462 to 2,239 umhos/cm at the outlet. This range was thought to be due to the tide-gates malfunctioning from debris.
- *pH*: pH in the Freshwater Marsh varied within the small range of 7.4 to 9.3, with an average of 7.8.
- *Turbidity*: Turbidity levels at the inlets ranged from 3.27 to 36.5 NTU with an average of greater than 10 NTU (nephelometric turbidity unit). The outlet levels were consistently lower, ranging from 0.74 to 5.67 NTU, with an average below five NTU.

7.4.2 Bacteria

There were no evident trends in bacterial concentrations within the Freshwater Marsh, although concentrations tended to be higher in wet weather samples than dry weather samples. The majority of the dry weather samples were above the Rec-1 criteria for fecal coliform during the 2003-2004 monitoring year. This is likely to be due to the presence of waterfowl within the marsh. Inlet bacteria concentrations range from 95 MPN/100 ml to >1600 MPN/100 ml, while outlet concentrations ranged from 4.1 MPN/100 ml to >1600 MPN/100 ml.

7.4.3 Toxicity

Acute and chronic toxicity sampling was conducted for *Pimephales promelas* (fathead minnow) and *Ceriodaphnia dubia* (water flea). All of the samples collected, except one during 2003-2004, had 100% survival of both species for acute and chronic testing. The exception to this was one inlet sample which had a 95% survival rate in the fathead minnow acute toxicity test. It was reported that this result was not statistically different from the tests where survival was 100%. Furthermore, the results of the chronic test showed 100% survival.

7.4.4 Metals

The majority of samples collected were below the method detection limit for metals. Those samples that did contain detectable concentrations were consistently less than the acute and chronic freshwater toxicity values for cadmium, copper, lead, and zinc. The ranges of concentrations for the detected metals are summarized in Table 7-4.

Table 7-4. Freshwater Marsh Metal Concentration Ranges

Metal	Form	Inlet Range (µg/l)	Outlet Range (µg/l)
Arsenic	Total	4 – 10	4.2 - 10
	Dissolved	4 – 10	4 – 9.1
Cadmium	Total	0.2U – 0.8	0.2U – 0.6
	Dissolved	0.2U – 0.6	0.2U – 0.2
Copper	Total	1.5 - 17	0.5U – 3.8
	Dissolved	1.4 -5.9	1.2 – 3.5
Nickel	Total	1.8 – 6.8	2 – 5.4
	Dissolved	1.8 – 6.4	1.9 – 4.9
Lead	Total	0.2U – 3.8	0.2U – 3.3
	Dissolved	0.2U – 1.3	0.2U – 0.9
Zinc	Total	2 - 65	1.7 - 25
	Dissolved	2 - 30	1.2 - 11

7.4.5 PAH, VOC, Pesticides, and Hydrocarbons

None of the samples collected had detectable levels of PAH, VOCs, PAHs, or PCBs.

7.4.6 Nutrients

Phosphorus concentrations measured within the Freshwater Marsh were generally low, less than 0.2 mgl^{-1}, which is typical of natural wetlands. Dissolved phosphorus concentrations at the inlets ranged from non-detect to 0.83 mgl^{-1} and the outlet ranged from non-detect to 0.25 mgl^{-1}. Total phosphorus concentrations ranged from 0.02 to 0.64 mgl^{-1} at the inlets and from 0.02 to 0.63 mgl^{-1} at the outlet.
Ammonia, nitrate, TKN, and nitrite were all measured in the Freshwater Marsh. Nitrite was below the method detection limit in all samples. Ammonia, nitrogen and TKN were well within the ranges typically reported for natural wetlands (0.4 to 1.7 mgl^{-1}; Kadlec and Knight, 1996). Nitrite levels were generally below the detection limits with a few exceptions in the winter months. Nitrate concentrations at the inlets ranged from non-detect to 0.47 mgl^{-1}, while nitrate concentrations at the outlet ranged from non-detect to 0.49 mgl^{-1}.

7.4.7 Particulates

The Freshwater Marsh was designed to reduce particulate concentrations from upstream runoff areas. The concentration in samples collected at the marsh outlet are less than the concentrations at the inlet. Inlet SSCs range from non-detect to 39 mgl^{-1}, while outlet concentrations ranged from non-detect to 15 mgl^{-1}.

7.4.8 Sediment Quality

With respect to metals, there were no spatial patterns observed in concentrations throughout the Freshwater Marsh. The metals concentrations in outlet sediments were consistently below the SQuiRT PEL values during all years sampled. The ranges of concentrations for the metals typically of most concern are listed in Table 7-5.

Table 7-5. Freshwater Marsh Sediment Metal Concentration Ranges

Metal	Inlet Range (mg/kg)	Outlet Range (mg/kg)
Arsenic	2.2 – 4.9	1.3 – 9.3
Cadmium	0.3 – 0.8	1.7 – 2.0
Copper	15 - 25	18 – 28
Nickel	8.2 - 17	12 – 19
Lead	5.1 - 34	5.7 – 7.4
Zinc	37 - 350	32 – 52

No pesticides, PCBs, or VOCs were detected in any of the sediment samples. There were some PAHs detected at the inlets, but concentrations were below NOAA probably effect levels.

7.5 LOCAL URBAN RUNOFF WATER QUALITY

Results of sampling and analysis of local urban runoff inputs are limited to characterization of runoff into the Freshwater Marsh as summarized above. Similar characteristics can be expected from runoff entering the tidal marsh from surrounding urbanized areas. Results of the analysis of stormwater samples entering the Freshwater Marsh from Jefferson Boulevard indicate the presence of constituents common to urban runoff, including metals, bacteriological indicators, and nutrients. The concentrations of these constituents compared to the WQO were reported to be below these criteria. Dissolved lead concentrations in the inlets were slightly below the chronic CTR. Stormwater entering the Freshwater Marsh from other areas that drain into the marsh should be characterized to determine potential impacts and monitored as part of the operation monitoring and maintenance program.

7.6 WATER QUALITY OF MARINA DEL REY AND SANTA MONICA BAY

Water and sediment quality, benthic infauna and fish surveys were conducted from 1994-2004 by the Aquatic Bioassay and Consulting Laboratories for the County of Los Angeles Department of Beaches and Harbors (LACDBH). The results of the 2003-2004 monitoring year and a comparison to historical data are presented in The Marine Environment of Marina Del Rey Harbor 2003-2004 (Aquatic Bioassay and Consulting Laboratories, 2004). The following discussion summarizes the findings of this report.

7.6.1 Water Quality

Water quality monitoring was conducted monthly at 19 stations within Marina Del Rey during 2003-2004. The locations of these monitoring stations are shown in Figure 7-5. The water quality parameters measured in the monitoring program include temperature, salinity, dissolved oxygen, pH, ammonia, biological oxygen demand, light transmittance, surface transparency, water color, total coliforms, fecal coliforms and enterococcus. Constituents with the most water quality objective exceedances include total coliforms, fecal coliforms and enterococcus. Indicator bacteria densities were compared to REC-1 criteria which are summarized in Table 7-6.

Table 7-6. REC-1 Bacteriological Standards

	30-Day Limit[1]	Single Sample Limit
Total Coliform	1,000 MPN/ 100 ml[2]	10,000 MPN/100 ml
Fecal Coliform	*200 MPN/ 100 ml*	400 MPN/ 100 ml
Enterococcus	35 MPN/ 100 ml	104 MPN/ 100 ml

1 = 30 day limit is based on the geometric mean of at least five weekly samples
2 = MPN is Most Probable Number

In general, the majority of bacterial exceedances occurred in Oxford Lagoon, the back-basins of Marina Del Rey and at Ballona Creek. There were 22 total coliform exceedances out of 228 measurements collected during 2003-2004. The majority of total coliform exceedances occurred in Oxford Lagoon (Stations 13 and 22) with a total of 13 exceedances. Exceedances were also observed in Basin E (Stations 10 and 20), at the Marina entrance (Station 1), at Ballona Creek (Station 12), and in Basin H (Station 7). Stations 10, 20, 1 and 12 each exceeded criteria two times during 2003-2004, while Station 7 exceeded once during the monitoring year. The number of exceedances in 2003-2004 were intermediate compared to previous years data. The least number of exceedances occurred in 1994-1995 with a total of 5, while the most exceedances occurred in 2001-2002 with a total of 35.

There were a total of 29 fecal coliform exceedances out of 228 measurements collected during 2003-2004. The majority of fecal coliform exceedances occurred in Oxford Lagoon (Stations 13 and 22), Basin E (Stations 10 and 20) and in Ballona Creek (Station 12). There were nine exceedances in Oxford Lagoon, seven exceedances in Basin E and five exceedances at Station 12 in Ballona Creek during 2003-2004. Exceedances were also observed in Basin D (Stations 18 and 19) with four exceedances and in Basin H (Station 7) with two exceedances. One exceedance during 2003-2004 was observed in Basin B (Station 6) and at Station 4 in the mid-channel. The number of exceedances in 2003-2004 was among the lowest compared to previous years data. The least number of exceedances occurred in 2000-2001 with 17, while the most exceedances occurred in 2001-2002 with 63.

There were a total of 21 enterococcus exceedances out of 228 measurements collected during 2003-2004. The majority of enterococcus exceedances occurred in Oxford Lagoon with eight exceedances and in Basin E (Stations 10, 11 and 20) with six exceedances. Exceedances were also observed in Basin D at Station 19 and in Ballona Creek at Station 12, each with two exceedances. One exceedance during 2003-2004 was observed in Basin F (Station 9), in the mid-channel (Station 25), and at the Ballona Creek mouth (Station 1). The number of exceedances in 2003-2004 was intermediate compared to previous year's data. The least number of exceedances occurred in 1994-1995 with two, while the most exceedances occurred in 2001-2002 with 44.

All other water quality constituents have generally remained within the average seasonal ranges during most sampling events throughout the monitoring period. However, decreased water quality has been observed in the back-basins of Marina Del Rey and in Oxford Lagoon (which drains into Basin E), including the highest temperature, pH, ammonia, and BOD values, and the lowest dissolved oxygen, light transmittance, and surface transparency levels. Oxford Lagoon and the back-basins of Marina Del Rey, especially Basins E and F, experience less circulation than the Marina entrance and the mid-channel. In addition, Basin F is located near the public boat launch where there is increased boat emissions and washing which may have contributed to the decreased water quality.

In general, the water quality in Marina Del Rey appears to be largely influenced by location. Stations located in Oxford Lagoon and Basin E, located farthest away from the Marina entrance, and Ballona Creek appear to have lower water quality and a greater number of bacteria exceedances compared to the stations located in the basins closer to the Marina entrance and in the mid-channel. Oxford Lagoon and Basin E receive less tidal mixing and circulation which most likely contributes to the degraded water quality, while stations in the main channel and in basins closer to the Marina entrance have displayed water quality measurements most similar to open ocean conditions. The majority of bacterial exceedances appear to be attributable to Ballona Creek or Oxford Lagoon drainages (Aquatic Bioassay and Consulting Laboratories, 2004). Sample results indicate that flows from Oxford Lagoon may directly impact Basin E and the other basins located at the upper end of Marina Del Rey, while flows from Ballona Creek may impact the Marina entrance and the main channel. With regard to potential inflows to the future restoration areas, the water quality in the main channel entrance that is adjacent to Area A (sampling stations 4 and 25) is significantly better with regard to bacteriological indicators, compared to the tidal section of Ballona Creek (sample Station 12). Furthermore, Basin H possesses lower water quality than the entrance channel adjacent to Area A, but higher than the tidal section of Ballona Creek (Station 12).

7.6.2 Sediment Quality

Sediment quality monitoring was conducted monthly at 15 stations within Marina Del Rey during 2003-2004. The locations of these monitoring stations are shown on Figure 7-5. The sediment quality parameters measured in the monitoring program include heavy metals, chlorinated pesticides and polychlorinated biphenyls (PCB's), undifferentiated organics, and minerals/other compounds. Sediment chemistry data was compared to the ER-L, ER-M and Apparent Effects Threshold (AET) (concentrations above which statistically significant biological effects always occur and are expected), and are presented in Table 7-7.

Table 7-7. Sediment Quality Thresholds

Constituent	ER-L	ER-M	AET
Metals			
Arsenic	8.2	70	50
Cadmium	1.2	9.6	5
Chromium	81	370	-
Copper	34	270	300
Lead	46.7	218	300
Mercury	0.15	0.71	1
Nickel	20.9	51.6	-
Silver	1	3.7	1.7
Zinc	150	410	260
Hydrocarbons			
p,p'DDD	2	20	10
p,p'DDE	2.2	27	7.5
p,p'DDT	1	7	6
Total DDT	1.58	180	-
Chlordane	0.5	6	2
Dieldrin	0.02	8	-
PCB's	22.7	180	370

In general, the majority of heavy metal concentrations were greater in the tidal section of Ballona Creek and the mid-channel and back-basins of Marina Del Rey compared to samples located near the Marina entrance during 2003-2004. Stations 5, 6, 9, 10, 11, and 25, which are located in either the mid-channel or back-basins, each had six metals that exceeded ER-L values. The ER-L threshold represents concentrations below which adverse biological effects are rarely observed, and is therefore a conservative criterion. Station 25 is located adjacent to Area A. Of the four stations located at or near the Marina entrance, only one metal exceeded the ER-L threshold at Stations 1 and 2. At Station 12, located in the tidal section of Ballona Creek, there were four ER-L (cadmium, copper, mercury, and lead) and one ER-M (zinc) exceedances. These findings are similar to historical data collected since 1997, in which metal concentrations were generally lowest at the Marina entrance and consistently higher in the mid-channel and back-basins of the Marina.

The highest concentrations of DDT's measured in 2003-2004 were in back-Basin F, in mid-channel and at the Marina entrance. There were a total of 19 DDT exceedances out of 22 measurements which occurred either in the back-basins, in mid-channel or the Marina entrance. Total PCB's exceeded the ER-M threshold only at Station 22 in Oxford Lagoon. These findings are similar to historical data collected since 1997, in which DDT and PCB concentrations were generally higher in the back-basins and Oxford Lagoon. Total DDT exceeded the ER-L in the sediment sample collected in the tidal section of Ballona Creek (Station 12). PCBs were below detection limits in the tidal section of Ballona Creek sample and the two stations adjacent to Area A.

Similar to heavy metals, DDT's, and PCB's, concentrations for the majority of undifferentiated organics were highest in the mid-channel and back-basins. These findings are comparable to historical data.

Similar to water quality, sediment quality also appears to be related to location within Marina Del Rey. The major sources of contamination appear to be Oxford Lagoon and Ballona Creek (Aquatic Bioassay and Consulting Laboratories, 2004). Since there is less tidal flushing in the back-basins and Oxford Lagoon, contaminants are able to settle out and persist in the sediments.

Sediment samples were also analyzed for benthic infauna composition. The Marina entrance and mid-channel had the highest species abundance, number of species and diversity, while the back-basins had generally lower abundances, number of species and diversity. These findings are similar to historical data collected since 1997.

The results of the sediment sampling and analysis in Marina Del Rey that included the tidal section of Ballona Creek, confirms previously summarized results that indicate exceedances of sediment quality criteria for metals (copper, lead, zinc and cadmium) and pesticides (DDT). PCBs were detected and exceeded criteria, but these impacted sediments appear to be localized to Oxford Lagoon. The sediment chemistry results for samples collected in the entrance channel adjacent to Area A (sampling stations 4 and 25) indicate similar sediment quality issues. Two primary sources of these impacts to sediment were identified, and included Oxford Lagoon and Ballona Creek.

7.7 SECTION 7 FIGURES

Figure 7-1. Drainage Areas and Stormwater Monitoring Station in Ballona Creek

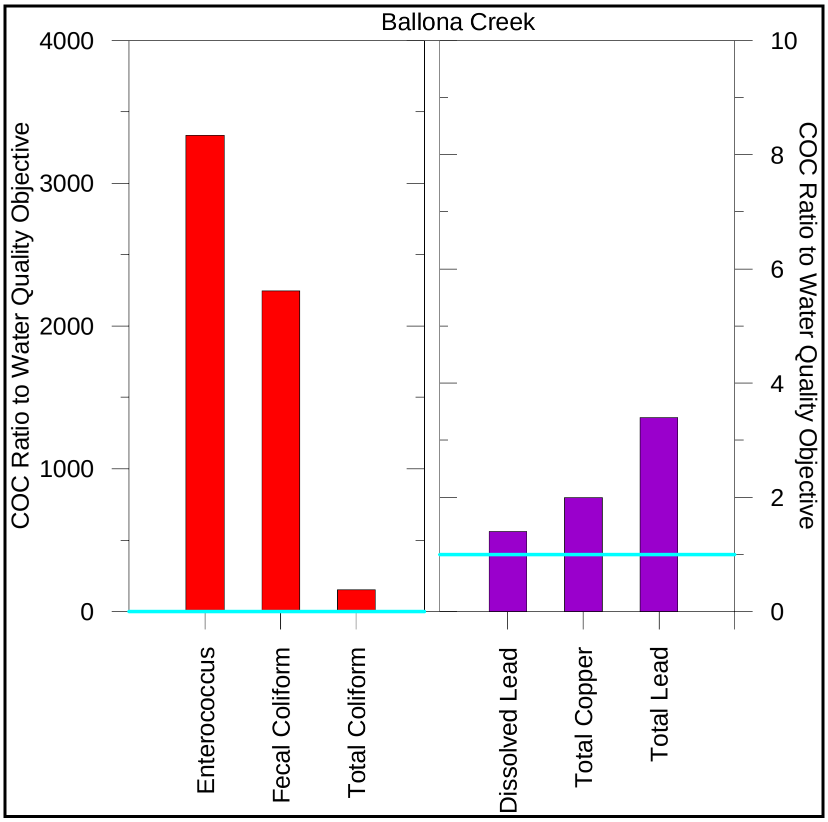

Figure 7-2. Mean Exceedance Ratio for Constituents Frequently Exceeding WQOs at Ballona Creek Mass Emission Site

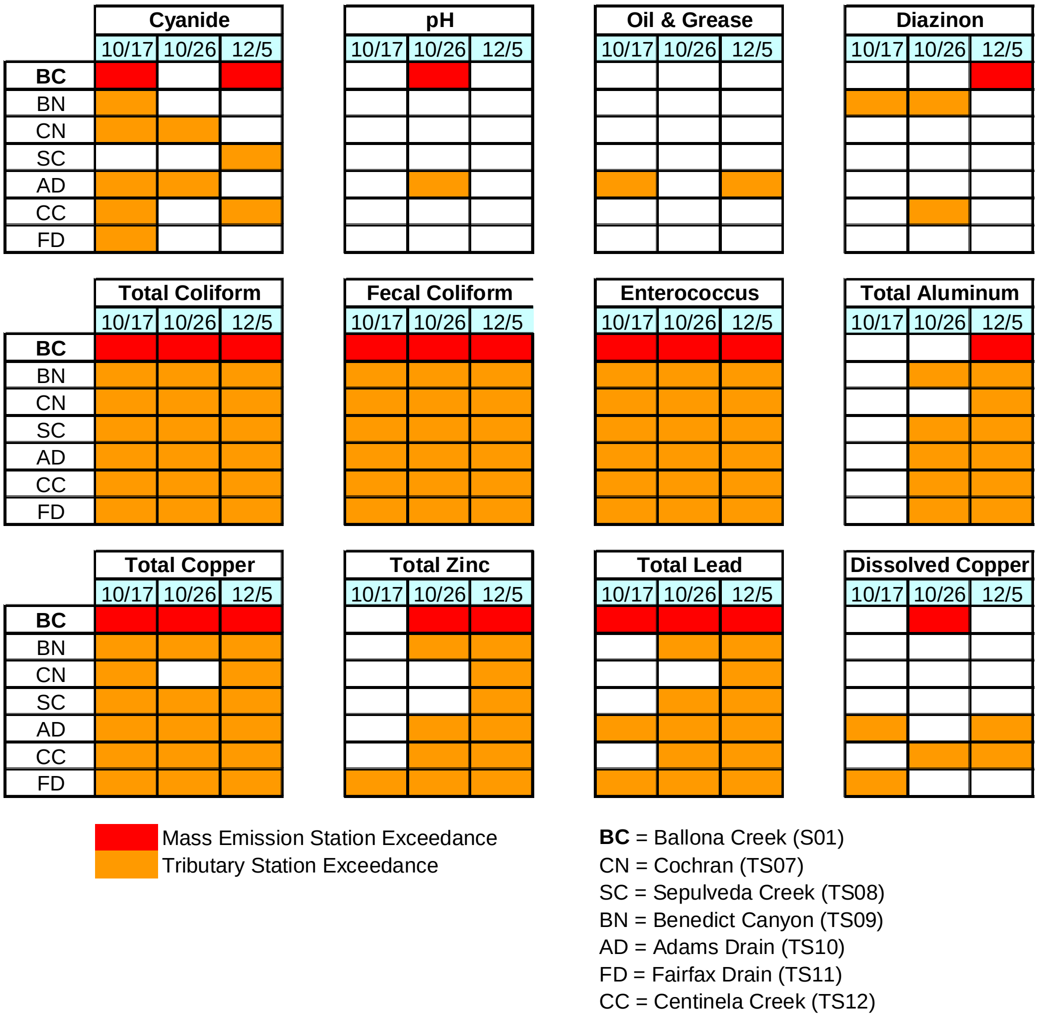

Figure 7-3. Comparative Summary of Constituents Frequently Exceeding WQOs at Ballona Creek and its Tributaries

Figure 7-4 Sediment Sampling Locations – tidal section of Ballona Creek – Bight03 Program

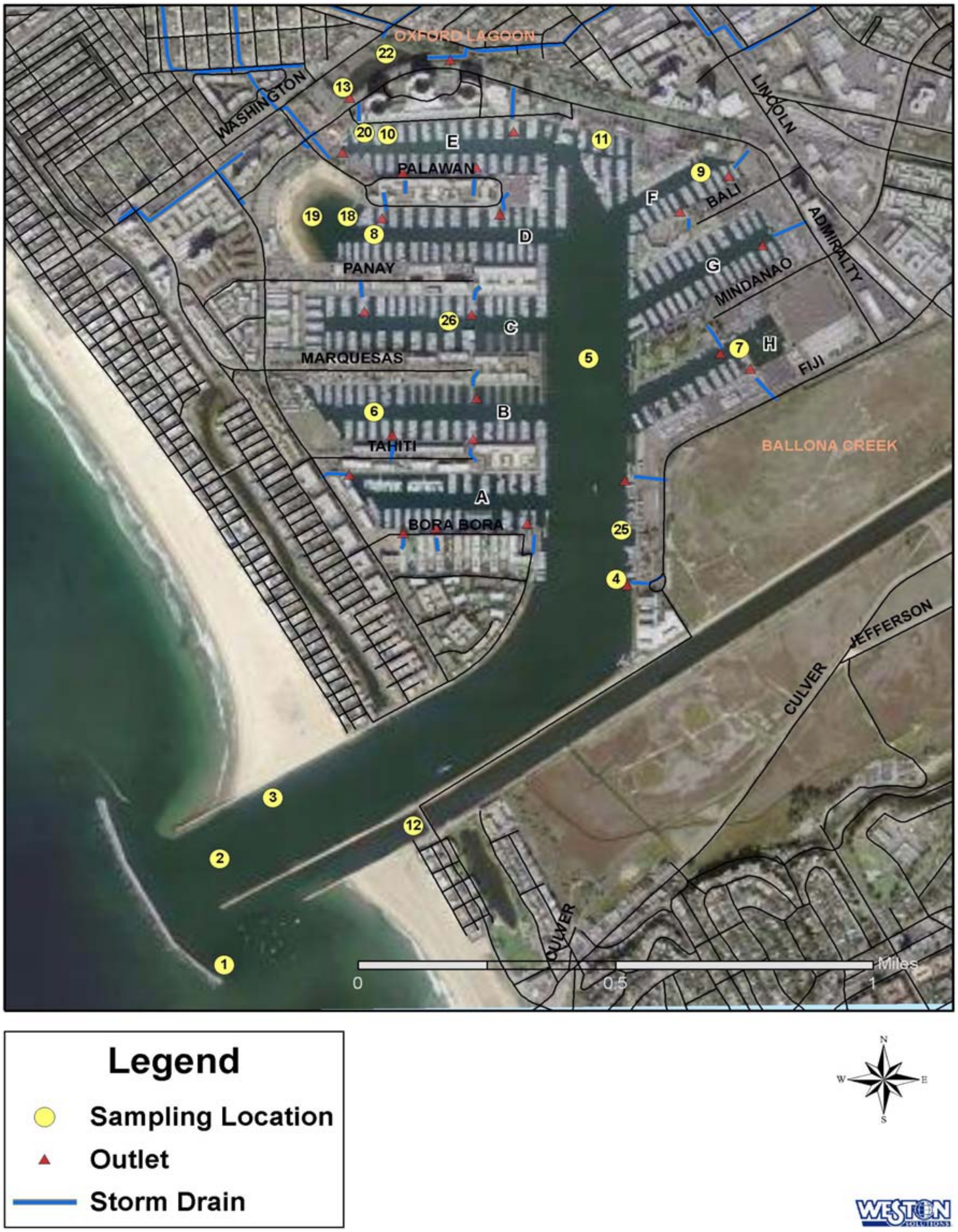

Figure 7-5. Sampling Location - Marine Del Rey Water Quality Sampling Program